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ECOLOGICAL STUDIES ON THE GENUS *AGROPYRON* IN ALBERTA

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Department of Field Crops

University of Alberta,

April, 1932.

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ECOLOGICAL STUDIES ON THE GENUS AGROPYRON
IN ALBERTA

Shirley Guy Preston
Department of Field Crops

A THESIS

submitted to the University of Alberta
in partial fulfilment of the requirements for
the degree of

MASTER OF SCIENCE

Edmonton, Alberta.
April, 1932

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ECOLOGICAL STUDIES ON THE GENUS AGROPYRON IN ALBERTA.

Introduction

Early investigations have revealed a number of problems of which the solutions are essential to a satisfactory analysis of the genus Agropyron.

The taxonomy of this genus is very uncertain. Early work at the University of Alberta has shown the necessity for pursuing morphological, ecological, cytological and genetical studies on the subject, and already considerable progress has been made, especially of a cytological and ecological nature. The classification of the species found in Alberta has been discussed at some length by Robinson (11) 1928, and Peto (7) 1930. The results obtained by these two workers demonstrated the necessity for studying the distribution of the prevailing species, and of collecting material suitable for further cytological and morphological analysis. An ecological investigation was accordingly undertaken to obtain information on the species of Agropyron in the province, and their relation to certain environmental factors as soil types, moisture, evaporation and to plant associations.

The genus Agropyron

The genus Agropyron is quite a large one, and as reported by Peto (1930), consists of about 60 species, 35 of which occur in Canada, and 10 in Alberta. These species are found chiefly in the North Temperate Zone and include several important range and cultivated grasses. The species which have been successfully brought under cultivation are A. tenerum (western rye-grass) and A. cristatum (crested wheat-grass). The former is indigenous to western and central Canada and United States, while the latter is a native of the Russian Steppes, (4). Of the range grasses, A. Smithii is the most important on the short grass plains, while A. tenerum and A. Richardsonii are among the principal components of the grass flora of the northern prairie, parkland and wooded areas of Alberta.

Literature review

Previous work on this genus is scanty and studies in Alberta have been chiefly confined to casual observations by botanists interested in the extension into Canada of the various associations of the western prairies of United States. Special notice has been given at times to this genus because of the economic importance of certain of the species, and because of the suspected frequency of interspecific hybridization.

There is little available literature by European workers. Raunkiaer, (10), 1926, studied the variations existing in A. repens, A. junceum and A. litoralle, terming these variations "isoreagents". He also made interspecific crosses to determine phylogenetic relationships.

Prodan (9) 1928 describes a new species, A. berezovcanum Prod. found in dry sandy places in Siberia. He found this species to be

intermediate between A. ramosum (Trin.) Richt., and A. pseudoagropyrum (Ledeb.). He also describes a variety of Agropyron, A. berezovcanum Prod. var. villosum Prod.

Malte (5) 1920 has done a good deal of work in selection of strains of A. tenerum. Later work (unpublished), deals with taxonomic relationships between A. tenerum and A. Richardsonii. Reference will later be made to correspondence concerning this work.

Moss (6) 1932 has made extensive studies on the general vegetation of Alberta, particularly from an ecological standpoint. With the observations made he was able to divide the province into vegetation zones, a very definite relation being observed between the grass flora and these large vegetation divisions, (Fig.I).

Stacey, (17) 1927 presented the results of an ecological study of the Grande Prairie - Beaverlodge district of northern Alberta. He noted the general occurrence of A. tenerum and A. Richardsonii also the presence on the prairie areas of A. Smithii, A. dasystachyum and A. Griffithsii whose northern limits are generally said to be farther south.

Robinson (11) 1928, undertook a study of the genus Agropyron at the University of Alberta. His work was necessarily preliminary and covered broad aspects of the subject. Much valuable material was collected, a tentative distribution map was constructed and some consideration was given to taxonomic difficulties.

Peto (7 & 8) 1930, carried the distribution investigation further and also designed a map showing the distribution of the species occurring within Alberta (Fig.II).

Clarke (2) 1930 is the most conversant with the grasses of the southern prairie of Alberta, and incidental to his studies he shows the relation of several species of _Agropyron_ to the prairie flora.

Soils, climate and vegetation of Alberta.

The soils of Alberta have been extensively studied by the Soils Department of the University of Alberta. The classification of soils as used by this department is as follows, (Figs. V-IX).

(a) Brown soil, characteristic of the southern prairie.
(b) Black soil of the parkland area.
(c) Grey soil of the wooded sections.
(d) Dark brown soil, between the black soil and brown soil belts.
(e) Grey-black transition.
(f) Black-grey transition.

The average annual precipitation as shown by the Dominion Meteorological Service Records, varies from 11 to 29 inches, (Fig.III). The southern prairie of the brown soil belt is characterized by a low precipitation, 11 to 17 inches, the parkland by 15 to 21 inches, and the wooded areas by 17 to 29 inches. The precipitation increases from east to west, being greatest along the foothills and in the Rocky Mountains.

The information on the vegetation divisions is insufficient to indicate definitely the limiting boundaries. These divisions are shown by the Natural Developement Bureau of the Department of the Interior (Figs. III - VIII). The principal vegetation zones of the province are as follows:

(a) Short grass plains, or southern prairie, of the south-eastern portion of the province.

(b) Northern prairie, or transition prairie belonging particularly to the dark brown soil area.

(c) Parkland area of the black soil section of central Alberta.

(d) Wooded area, covering most of the grey soil section.

(e) Cordilleran forest of the foothills and Rockies.

There is seldom a well defined line of demarcation between these zones so the boundary lines at best indicate only the general trend of the vegetation.

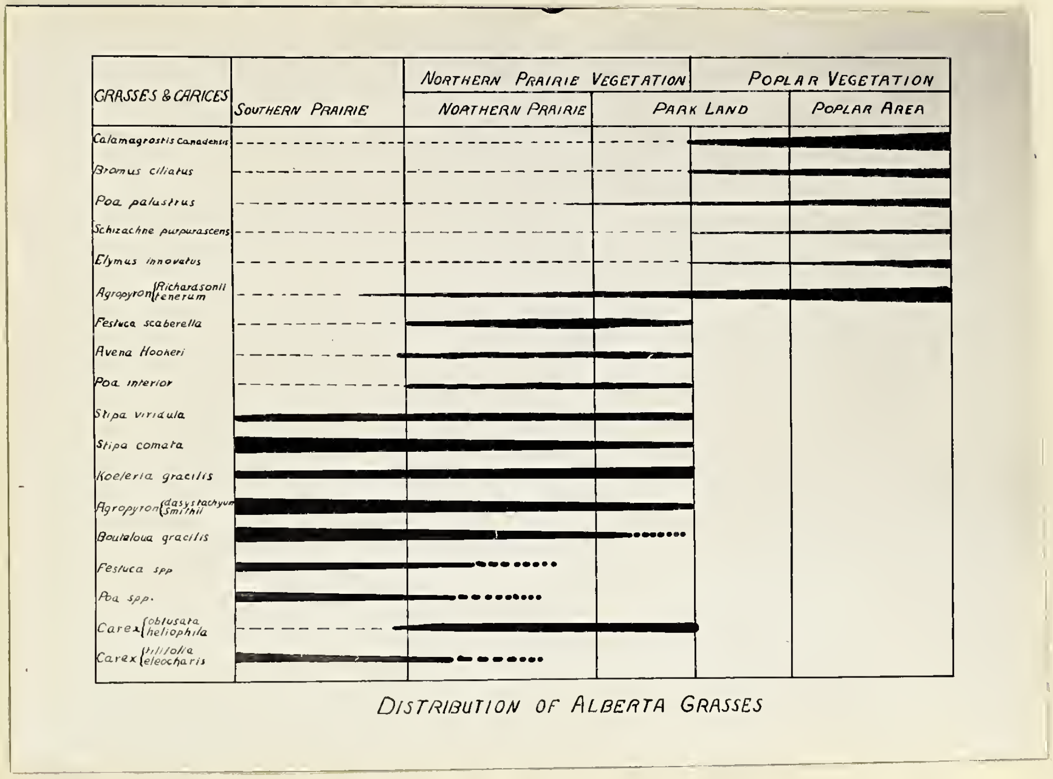


Fig. I.

Distribution of the principal grasses and Carices of of Alberta (6). (Drawn with slight modifications from photograph).

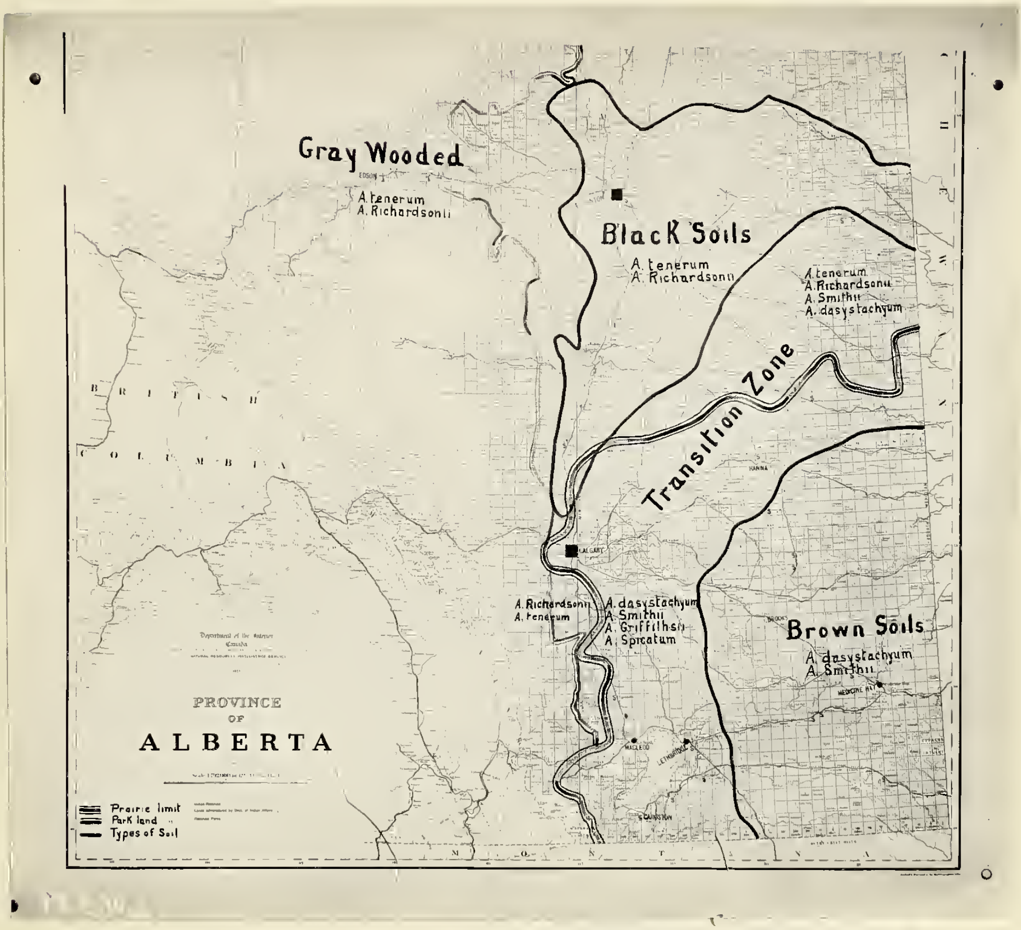


Fig. II.

Distribution of *Agropyron* species in Alberta (7).

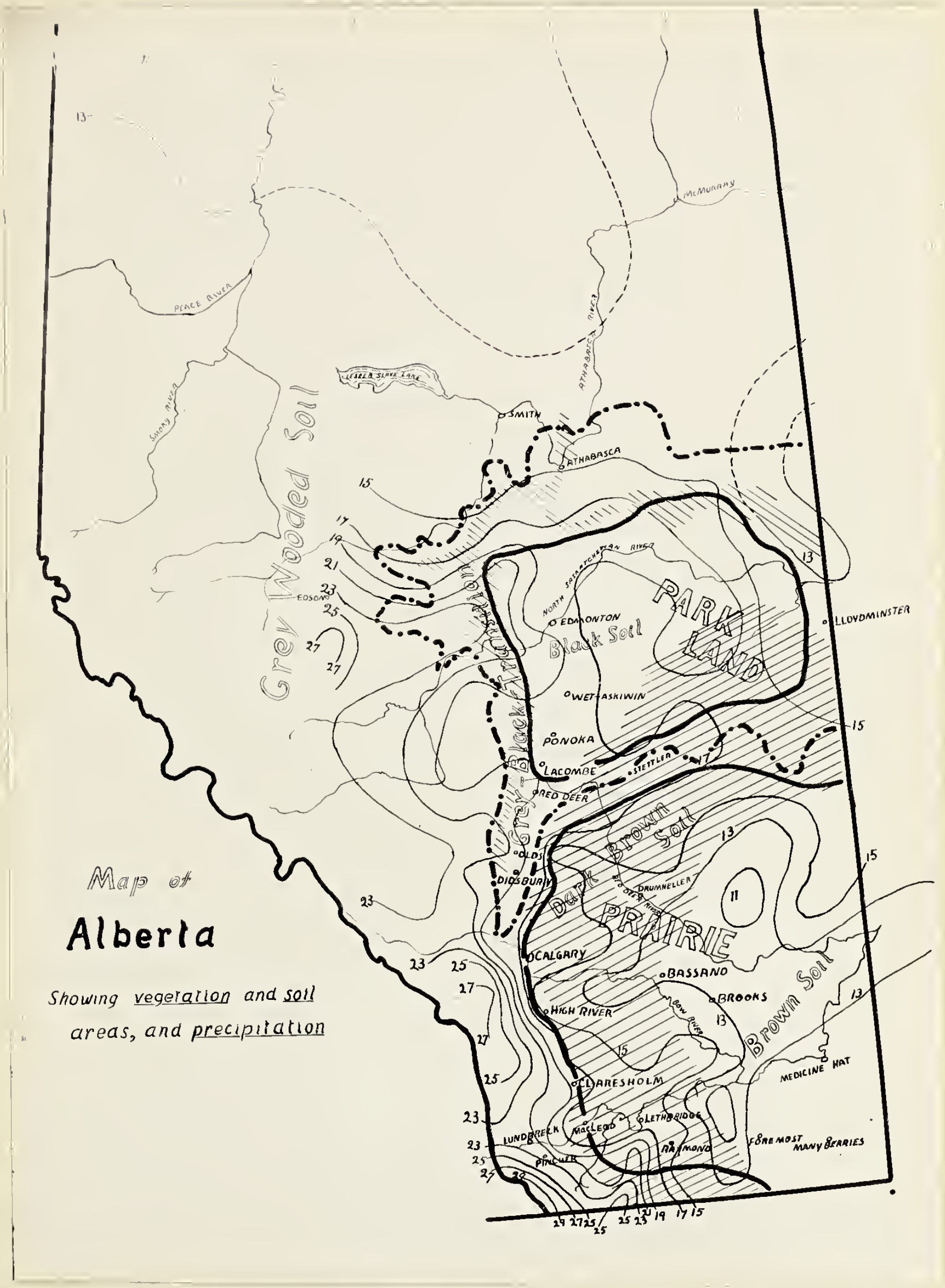

Map of
Alberta
Showing vegetation and soil
areas, and precipitation
Grey Wooded Soil
Grey-Black Transition
Black Soil
PARK LAND
Dark Brown Soil
PRAIRIE
Brown Soil
PEACE RIVER
SMOKY RIVER
LESSER SLAVE LAKE
ATHABASCA RIVER
McMurray
SMITH
ATHABASCA
EDSON
NORTH SASKATCHEWAN RIVER
EDMONTON
LLOYDMINSTER
WETASKIWIN
PONOKA
LACOMBE
STETTLER
RED DEER
OLDS
DIDSBURY
DRUMHELLER
RED DEER RIVER
CALGARY
BASSANO
BROOKS
BOW RIVER
HIGH RIVER
MEDICINE HAT
CLARESHOLM
LETHBRIDGE
MacLEOD
LUNDBRECK
PINCHER
RAYMOND
FOREMOST
MANY BERRIES
11
13
15
17
19
21
23
25
27

Fig. III.

Methods

The data for this investigation were obtained through field work carried on throughout central and southern Alberta during the summers of 1930 and '31, also information of essential nature was obtained from the observations of Robinson (11) 1928, Peto (7) 1930 and Moss (6) 1932.

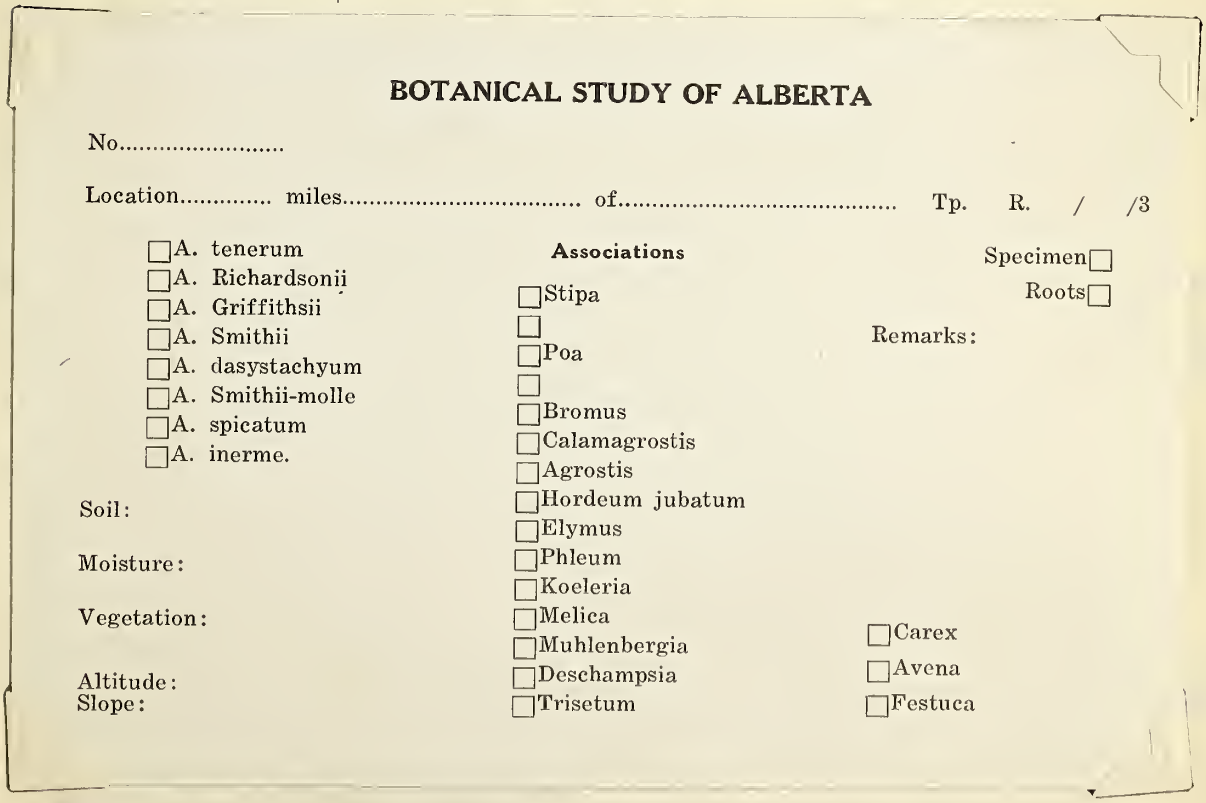
The survey was very general, but was conducted in such a manner that representative portions of the principal vegetation and soil areas were covered. Travel was wholly by car, usually in co-operation with the Division of Plant Pathology of the University.

During the first season a number of trips were made. The first was from Edmonton to Manyberries, via Calgary, Brooks and Medicine Hat, returning by way of Foremost, Stirling, Lethbridge McLeod and Calgary. On the second trip the area between Edmonton and Calgary was given considerable attention while the following places south were visited: Claresholm, Lethbridge, Cardston, Waterton Lakes, Pincher Creek and Crow's Nest. Two trips were made to Lloydminster, returning on the first by way of Wainwright, Tofield and Wetaskiwin, and on the second by Tofield, New Serepta and Bretonia. Later in the summer, a trip was made to Morinville, Sangudo and Cherhill, and another by way of Clyde, Thorhild, Waskatineau and Fort Saskatchewan. Trips of short duration were also made to Breton and Athabasca, but weather conditions and scarcity of time prevented the making of a critical examination of the vegetation.

During the second season, 1931, some new territory was covered and by a certain duplication of routes certain of the features

overlooked in 1930 were examined. The first trip was of three weeks duration and the following places were visited: Wetaskiwin, Camrose, Stettler, Big Valley, Drumheller, Bassano, Brooks, Vauxhall, Taber, Bow Island, Lethbridge, Raymond, McGrath, Shouldice, Gleichen, Strathmore, Three Hills, Innisfail, Red Deer, Alix, Mirror, Lacombe and Edmonton. Later, trips of shorter duration were made to Mayerthorpe and Rochfort, Athabasca and Lac La Biche, and Edson.

Stops were as a rule made every 5 to 15 miles, and an attempt was made at all times to take observations on natural vegetation only. This is often particularly difficult as the advent of cultivation has caused a marked change in the adjacent undeveloped areas. Notes were taken on species of Agropyron, associated plants, soil type, moisture and vegetation, and were recorded on cards devised for the purpose, (Fig.IV).



BOTANICAL STUDY OF ALBERTA

No........................

Location............. miles................................. of... Tp. R. / /3

☐A. tenerum
☐A. Richardsonii
☐A. Griffithsii
☐A. Smithii
☐A. dasystachyum
☐A. Smithii-molle
☐A. spicatum
☐A. inerme.

Soil:

Moisture:

Vegetation:

Altitude:
Slope:

Associations

☐Stipa
☐
☐Poa
☐
☐Bromus
☐Calamagrostis
☐Agrostis
☐Hordeum jubatum
☐Elymus
☐Phleum
☐Koeleria
☐Melica
☐Muhlenbergia
☐Deschampsia
☐Trisetum

Specimen☐
Roots☐

Remarks:

☐Carex
☐Avena
☐Festuca

Fig. IV. Survey card.

Identification of Agropyron species

The identity of certain of the Agropyrons has at times been a source of difficulty and annoyance. It was found necessary, for the purpose of this investigation, to revise somewhat the classification, giving species value only to forms which were considered to vary significantly from one another.

Much of the confusion in classification is due apparently, to interspecific hybridization with a resulting gradation of forms. A brief review of the native species will now be undertaken with particular reference to difficulties encountered in identification studies.

Agropyron tenerum[1] is represented by numerous variants. Peto (7) found a complete gradation of forms between A. tenerum and A. Richardsonii, which suggests that these forms hybridize readily; also because of almost complete self-fertility these forms are found to breed true (5).

Agropyron Richardsonii has been variously designated A. caninum and A. caninoides, the former from its resemblance to the European species of that name and the latter as a new name, synonymous with A. Richardsonii. Malte, through correspondence, states he originally considered A. Richardsonii and A. caninum identical, but after making comparisons of type specimens in European herbaria finds they are quite distinct species, and further suggests A. Richardsonii as the most suitable name for the American species.

[1] In a recent publication ((Malte M.O. - The so-called Agropyron caninum (L) Beauv. of North America - Rept. of the Nat. Museum of Can. 1930)) these species are combined under an early name, A. trachycaulum Link, and the various forms designated as varieties.

A. Smithii is seldom confused with other species, except on rare occasions when extreme forms are found which closely resemble *A. repens*, These species may be differentiated, however, on glume characteristics.

A. Smithii-molle resembles *A. Smithii* as far as known, with the exception that the lemmas of the former are finely pubescent and those of the latter glabrous.

A. dasystachyum and *A. Smithii-molle* are often confused because of the occurrence of intermediate forms. Rydberg further divides the *A. dasystachyum* type into, *A. lanceolatum*, *A. subvillosum* and *A. dasystachyum*, but this classification adds to, rather than dimishes the difficulty encountered in the differentiation of related species.

A Griffithsii and *A. albicans* were found to differ significantly only in pubescence of the lemma (11). For purposes, then, of an ecological investigation, these forms have been designated as *A. Griffithsii* (Table I).

A. spicatum is of rare occurrence in Alberta, reports of a general distribution in southern Alberta being due, apparently to confusion with *A. Griffithsii* which it resembles closely except in root characteristics, (Table I).

Table I

KEY TO THE GENUS AGROPYRON
(For the species occurring in Alberta)

Plants with creeping root-stocks or stolons-

Lemmas with short awns or awnless-

Lemmas densely pubescent..........A. dasystachyum

Lemmas scabrous or glabrous,
(finely pubescent in A. Smithii-molle)

Empty glumes 5-9 nerved;
Spikelets 4-6 flowered, 9-14 mm. in length;
Basal leaf-sheath usually pubescent;
Leaves green, flat, thin, with fine, scarcely prominent nerves;
Root-stocks coarse............A. repens

Empty glumes 1-3 nerved;
Spikelets 7-12 flowered, 15-28 mm. in length;
Leaves bluish-green, smooth on the lower surface, rough on the upper;
Root-stocks fine..............A. Smithii

Same as A. Smithii, but lemmas finely pubescent
.......A. Smithii-molle

Lemmas long-awned, more or less divergent or kneed;
Lemmas glabrous or pubescent......A. Griffithsii

Plants with no root-stocks or stolons-

Glumes about as long as the spikelets-

Spikelets terete, appressed;
Awn not longer than the lemma..A. tenerum

Spikelets unilateral, appressed;
Awn usually about twice as long as the lemma.
......A. Richardsonii

Glumes much shorter than the spikelets;
(Awns long, divergent; Spikelets distant on rachis)................A. spicatum

TABLE II

		Moisture	Soil	Vegetation	A. tenerum	A. Richardsonii	A. Smithii	A. S.-molle	A. Griffithsii	A. dasystachyum	A. spicatum	P. triflora	P. pratensis	B. ciliatus	B. inermis	C. canadensis	A. hyemalis	A. alba	Avena striata	M. racemosa	M. cuspidata	E. innovatus	E. canadensis	P. pratense	H. jubatum	S. columbiana	S. comata	S. viridula	K. gracilis	B. gracilis	S. gracilis	F. ovina (Forms)	Trisetum	Carex spp.
Medicine Hat,	40 mi S	X	Br	Pr	x	x	x																				x		x	x				
Walsh,	16 mi S	X	Br	Pr	x	x	x								x												x		x	x				
Manyberries,	16 mi S	X	Br	Pr	x	x	x																				x	x	x	x				
Foremost,	25 mi W	X	Br	Pr	x	x	x																				x	x	x	x				
McGrath,	2 mi SE	X	S	Pr			x																				x			x			x	
Raymond,	2 mi E	X	D Br	Pr			x																			x			x			x	x	
Lethbridge,	(gaol)	X	D Br	Pr			x						x													x			x					
"	4 mi E	X	D Br	Pr	x		x											x						x	x		x		x	x				
" (Auto camp)		X	D Br	Pr			x																				x		x	x		x		
"	4 mi SW	X	D Br	Pr			x																				x		x	x		x		
Coaldale,		X	D Br	Pr			x						x				x	x						x	x		x			x		x		
"	4 mi E	X	D Br	Pr	x	x	x						x											x	x	x	x		x	x				
Taber,	6 mi SE	X	D Br	Pr	x		x						x														x		x	x				
"	10mi SE	X	Br	Pr			x																				x		x	x		x		
"	8 mi SW	X	Br	Pr			x																						x	x				
"	8 mi W	M	Br	Pr			x											x						x	x				x	x		x		
Vauxhall,	7 mi N	M	Br	Pr	x		x								x										x									
"	10 mi N	M	Br	Pr			x	x		x																	x			x				
Eyremore,	(bridge)	M	Alk	Pr	x		x						x					x								x			x	x	x			
Ranier,	4 mi NW	M	Br	Pr			x																		x					x				
"	6 mi SW	X	Alk	Pr	x		x	x		x		x									x		x			x	x			x				
"	2 mi S	M	S	Pr			x																							x				
Scandia,		M	Br	Pr			x					x	x			x														x		x		
"	½ mi E	M	Br	Pr			x	x		x		x						x							x		x			x				
"	4 mi E	M	Br	Pr			x						x												x				x	x				x
Brooks,	(C.P.R.)	X-M	Br	Pr	x	x	x	x		x		x														x	x		x	x				
"	1½ mi S	X	Br	Pr	x		x																		x		x		x	x				
"		X	Alk	Pr	x		x			x		x	x												x				x	x				
"	7 mi NE	M	Br	Pr			x																		x		x		x	x				
"	3½ mi NE	M	Br	Pr			x					x												x	x									
"	3 mi E	X	Br	Pr	x		x					x													x	x			x					
Rosemary,	4 mi S	M	Br	Pr			x					x	x					x																
Hussar,	17 mi N	X	Br	Pr			x																				x	x		x				
"	19 mi N	X	Br	Pr		x	x																		x	x	x		x	x				
Drumheller,		X	Cl	Pr			x														x						x	x		x				x
Morrin	2 mi S	X	D Br	Pr		x	x	x		x		x														x								
"	3 mi N	X	Br	Pr			x																				x		x			x		
Rumsey,	3 mi S	X	Br	Pr	x	x	x		x																x		x		x	x		x		
Scollard,		X	Br	Pr	x	x	x																							x	x			
Big Valley,	2 mi S	X	Br	Pr	x		x		x			x			x											x			x			x		
Stettler,	4 mi N	X	Br	Pr			x									x								x	x		x		x					
Meeting Creek,		X	Br	Pr			x									x								x	x		x		x					
Camrose,	13 mi SE	X	B	Pk	x	x	x																											
"	8½ mi S	M	B	Pr	x	x	x					x														x	x							
"	10 Mi NW	M	B	Pk	x	x	x					x														x	x							
McLeod							x																				x		x					
Cardston,					x	x	x																				x		x					
Pincher Creek,					x	x	x			x													x											
Lundbreck,to Claresholm					x	x	x	x	x	x	x	x									x		x											

Moisture

Dry(xeric)..........X
Intermediate(mesic).M
Wet (hydric)........H

Soils

Brown...........Br.
Dark brown.......D Br
Black...........B
Grey (wooded)....G
Clay............Cl
Sandy...........S
Alkaline........Alk

Vegetation

Prairie........ Pr.
Parkland....... Pk
Wooded......... W

		Moisture	Soil	Vegetation	A. tenerum	A. Richardsonii	A. Smithii	A. S.-molle	A. Griffithsii	A. dasystachyum	A. spicatum	P. triflora	P. pratensis	B. ciliatus	B. inermis	C. canadensis	A. hyemalis	A. alba	Avena striata	M. racemosa	M. cuspidata	E. innovatus	E. canadensis	P. pratense	H. jubatum	S. columbiana	C. comata	S. viridula	K. gracilis	B. gracilis	S. gracilis	F. ovina (Forms)	Trisetum	Carex spp.
High River,	12 mi E	X	B	Pr	x	x	x																		x		x							
Cayley,	4 mi SE	M D	Br	Pr	x	x	x																				x			x				
Granum,		M D	Br	Pr	x	x	x																				x			x				
Blairmore,		M		W	x	x	x															x												
Claresholm,	20 mi W	X D	Br	Pr	x	x	x	x	x																									
Blackie,	2 mi S	X D	Br	Pr	x	x	x																											
Edberg,	4 mi S	X D	Br	W	x	x							x	x																				
Camrose,	13 mi SE	X D	Br	W	x	x	x																											
"	8½ mi S	X D	Br	Pr	x	x						x														x								
"	8 mi S	M	B	Pr	x	x						x		x			x							x	x	x								
Drumheller,	22 mi NW	X	Br	Pr	x	x	x			x		x		x												x	x		x	x				
Three Hills,	9 mi E	X	Br	Pr	x	x	x														x					x	x		x	x				
"	3 mi E	X D	Br	Pr	x		x		x																x		x		x					
Trochu,		M	Alk	Pr	x	x			x			x			x										x				x					
"	5 mi NW	M D	Br		x	x	x					x	x											x			x							
Innisfail,	15 mi E	M D	Br	Pr		x								x			x				x								x					
"	20 mi E	M	B	Pr	x	x	x		x																x		x							
Sylvan Lake,	2 mi E	M	G	W	x	x							x	x		x								x										
Delburne,	3 mi NE	M	B	W	x	x						x	x	x			x				x						x		x					
"	8 mi N	M	B	W	x	x						x	x	x							x			x			x							
Alix,	4 mi SW	M	B	W	x	x						x	x	x											x				x					
Mirror,	6 mi S	M	B	W	x	x			x																		x		x					
"	3 mi W	M	B	Pr	x	x	x						x	x							x					x	x		x	x				
Gull Lake,		M	G	W	x							x	x			x																		
Olds,	4 mi W	M	B	Pr	x	x																					x							
"	13mi SW	M	Cl	W	x	x	x	x																										
"	9 mi E	M	B	Pr	x	x	x		x																		x							
Vulcan,	22 mi NW	X D	Br	Pr		x	x																				x							
"		X D	Br	Pr	x	x	x			x																	x							
Edmonton,	6 mi W	M	B	Pk	x	x						x	x	x			x							x					x					
"	8 mi SW	M	B	Pk	x	x						x	x	x			x							x					x					
Oliver,	1 mi N	M	B	Pk	x	x							x		x														x					
"	2 mi NE	M	B	Pk		x						x	x						x															
"	6 mi E	M	B	Pk	x	x						x	x	x																				
Vegreville,	5 mi E	M	B	Pr	x	x	x					x														x								
Ranfurly,	6 mi SE	M	B	Pk	x	x	x					x																						
"	5 mi E	M	B	Pk		x	x													x						x			x					
Manville,	2 mi E	M	B	Pk	x	x		x	x	x																	x							
Vermilion,		M	B	Pk	x	x	x																			x								
"	19 mi E	M	Cl	Pr		x	x			x																								
Lloydminster,	4 mi W	M	Cl	Pr		x	x																			x								
McLaughlin,		M	Cl	Pr		x	x			x																								
Blackfoot,	19 mi S	X D	Br	Pr	x	x	x	x		x																	x							
Wainwright,	5 mi E	X D	Br	Pr		x	x		x																									
"	5 mi NW	X D	Br	Pr	x	x	x		x	x																	x							
"	19 mi W	X D	Br	Pr		x	x	x	x																		x							
Irma,	2 mi W	X D	Br	Pr		x	x																				x			x				
Viking,	8 mi SE	X D	Br	Pr		x	x		x																		x		x	x				
"	4 mi W	M D	Br	Pr		x	x		x																		x		x	x				
"	20 mi NW	X D	Br	Pr	x	x		x	x	x																			x	x				

		Moisture	Soil	Vegetation	A. tenerum	A. Richardsonii	A. Smithii	A. S.-molle	A. Griffithsii	A. dasystachyum	A. spicatum	P. triflora	P. pratensis	B. ciliatus	B. inermis	C. canadensis	A. hyemalis	A. alba	Avena striata	M. racemosa	M. cuspidata	E. innovatus	E. canadensis	P. pratense	H. jubatum	S. columbiana	S. comata	S. viridula	K. gracilis	B. gracilis	S. gracilis	F. ovina (Forms)	Trisetum	Carex spp.
Haight,	1 mi N	M	Cl	W	x								x																					
Tofield,	5 mi E	M	S	W	x		x		x	x		x																						
"	3 mi E	M	S	Pr	x	x	x		x	x		x																						
"	2 mi SW	M	D Br	Pr	x	x			x																									
Kingman,	10 mi W	M	D Br	W	x	x								x		x																		
New Serepta,	4 mi NW	M	G	W	x	x						x	x	x		x																		
St. Albert,	1 mi N	M	B	Pk	x	x						x	x	x			x			x				x										
"	4 mi N	M	B		x	x						x	x	x		x	x			x				x										
Morinville,	2 mi N	M	B	Pk	x	x						x	x	x		x	x			x				x										
Clyde,	12 mi S	M	Br	W	x	x						x	x			x			x	x				x										
"	8 mi S	M		W	x							x	x	x																				x
"	3 mi NW	M	S	W	x	x						x	x	x		x	x			x		x										x		
"	3 mi N	M			x	x						x		x			x																	
"	5 mi W	M	G	W	x	x						x	x	x			x																	
Westlock,	2 mi NE	M	G	W	x	x						x		x																				
"	6 mi N	M	G	W	x	x						x		x		x																		
"	10 mi NW	M		W	x	x						x		x		x								x										
Tawatinaw,	2 mi N	M	S	W	x	x						x	x	x			x		x			x												
Rochester,	4 mi N	M	S	W	x	x						x		x					x			x												
Colinton,		M	G	W	x	x						x		x										x										
Athabasca,	3 mi S	M	G	W	x	x						x		x		x						x												
"	9 mi S	M	Br	W	x							x		x		x			x			x												
Donàtville,	2 mi NE	M	G	W	x							x		x					x			x		x										
Colinton,	36 mi NE	M	G	W	x							x		x		x	x					x												
Lac La Biche,	24 mi NW	M	S	W	x							x	x	x		x	x		x			x												
" "	18 mi W	M	G	W	x	x								x		x																		
" "	1 mi SW	M	B	W	x	x						x	x	x		x						x												
" "	6 mi NW	M	G	W	x	x						x	x	x		x						x			x									
" "	20 mi W	M	G	W	x	x						x		x		x																		
Villeneuve,	2 mi NW	M	B	Pr	x	x						x	x			x				x				x										
"	4 mi NW	M	B	W	x	x						x	x	x		x						x		x										
"	5 mi NW	M	B	W	x							x	x	x		x																		x
Calaboo,	(Creek)	H	G	W	x							x	x	x		x																		x
Onaway	1 mi NW	M	G	W	x	x						x	x	x		x	x		x															
Gunn,	2 mi N	H		W	x	x						x	x	x		x	x																	
"	15 mi NW	M	G	W	x							x	x	x								x												
Cherhill,	1 mi N	M	G	W	x							x	x	x		x	x		x					x										x
"	14 mi E	M	G	W	x	x						x		x																				
"	1 mi E	M	G	W	x							x		x		x						x		x										
Sangudo,	4 mi S	M	S	W	x	x						x		x		x						x												
"	4 mi SE	M	G	W	x	x						x					x																	
"	4 mi N	M	G	W	x	x						x		x										x										
Mayerthorpe,	2 mi N	M	G	W	x	x						x	x	x																				
"	5 mi NE	M	G	W	x	x						x		x		x								x										
Rockford,	9 mi NE	M	G	W	x							x		x					x			x												
"	5 mi N	M	G	W		x						x		x					x			x												

	Stony Plain, 5 mi W	Wabamun, 8 mi E	"	" 3 mi W	Seba,(Beach)	" 4 mi W	Entwistle, 2 mi NW	" 8 mi W	Chip Lake,	" 6 mi W	Granada,	Edson, 10 mi E	" 7 mi E	"
Moisture	M	M	M	M	M	M	M	H	H	M	M	M	M	M
Soil	G	G		G	G	G	G	G		S	G	G	G	C
Vegetation	W	W		W	W	W	W	W		W	W	W	W	W
A. tenerum	x	x	x	x		x	x	x	x	x	x	x	x	x
A. Richardsonii		x	x	x	x	x		x			x			
A. Smithii														
A. S.-molle														
A. Griffithsii														
A.dasystachyum														
A. spicatum														
P. triflora		x	x	x	x	x		x	x	x	x	x	x	x
P. pratensis		x		x										
B. ciliatus	x	x	x	x		x	x	x	x				x	
B. inermis														
C. Canadensis	x	x	x		x	x	x	x	x	x	x	x	x	x
A. hyemalis		x		x								x		x
A. alba														
Avena striata										x	x		x	x
M. racemosa														
M. cuspidata														
E.innovatus			x			x		x			x	x	x	
E. canadensis					x		x							
P. pratense												x		
H. jubatum														
S. columbiana														
S. comata														
S. viridula														
K. gracilis														
B. gracilis														
S. gracilis														
F. ovina (Forms)														
Trisetum														
Carex spp.	x		x						x		x			

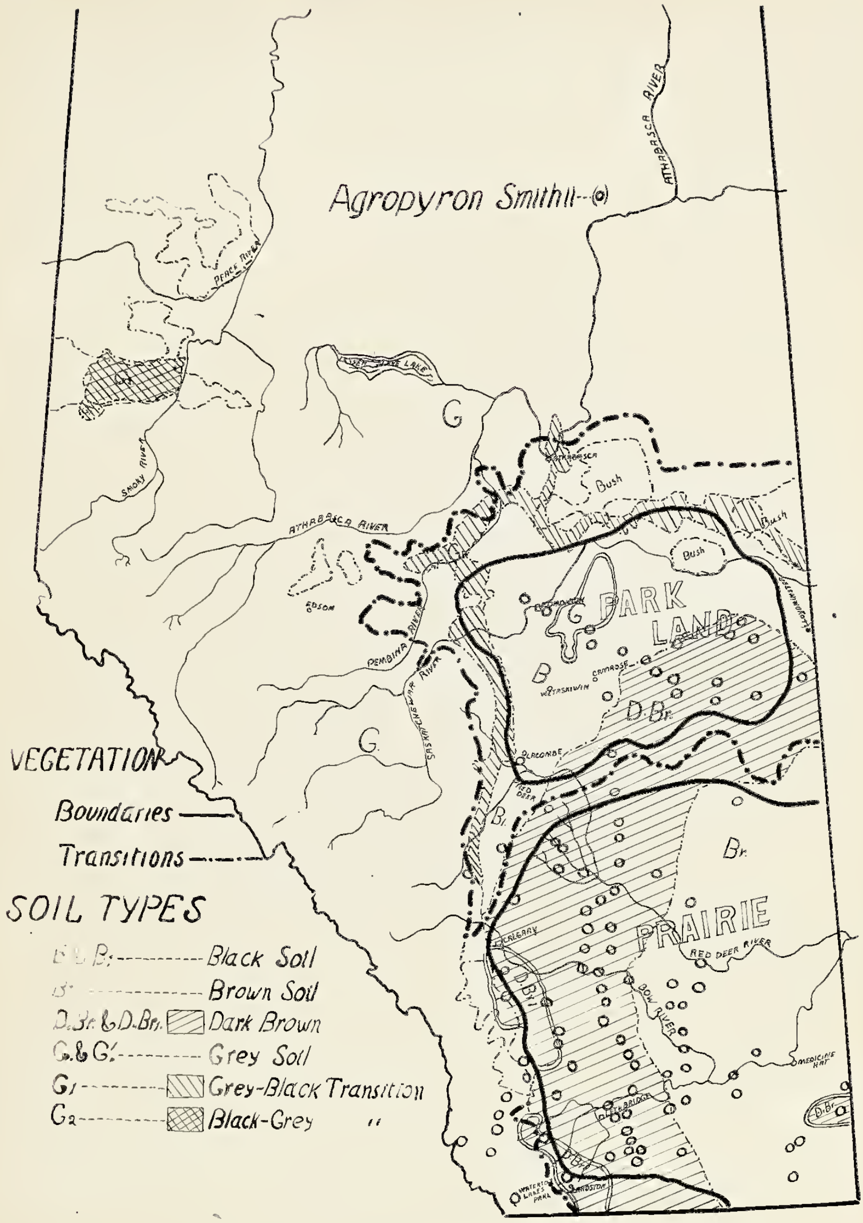


Fig. V

Distribution of A. Smithii in Alberta.

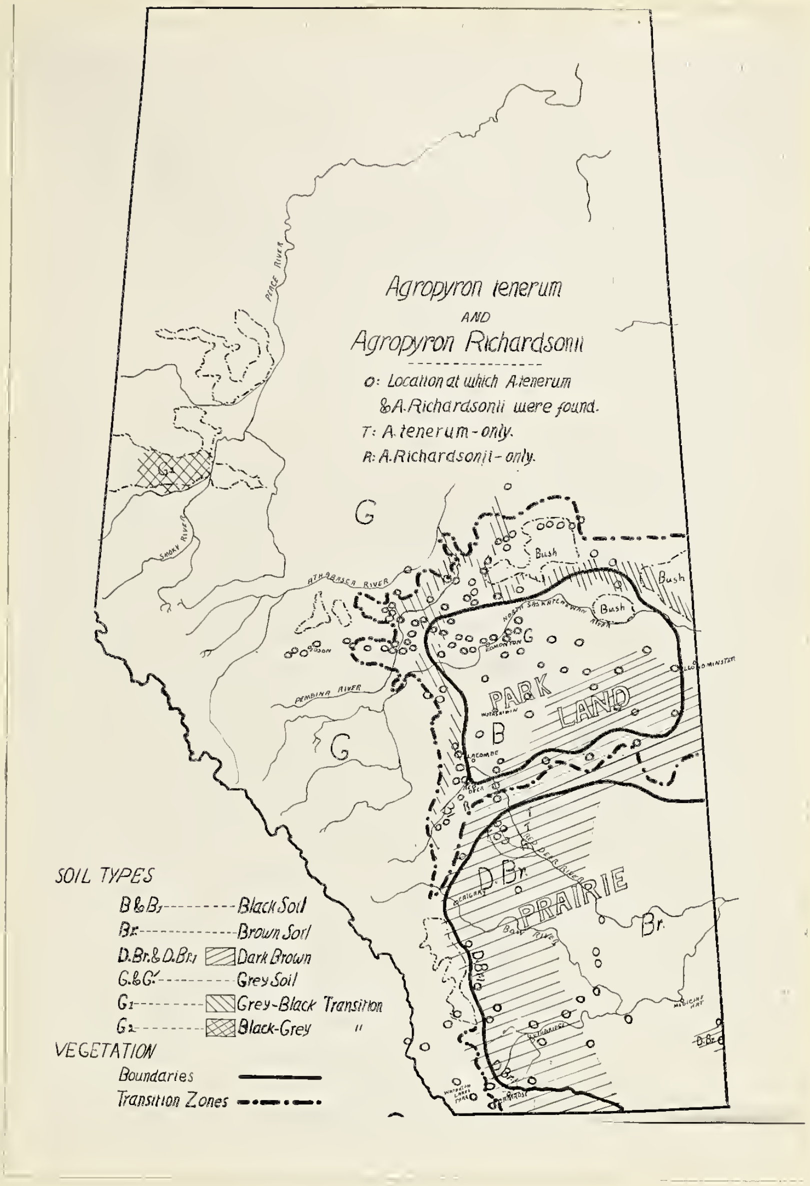


Fig. VI.

Distribution of A. tenerum and A. Richardsonii

in Alberta.

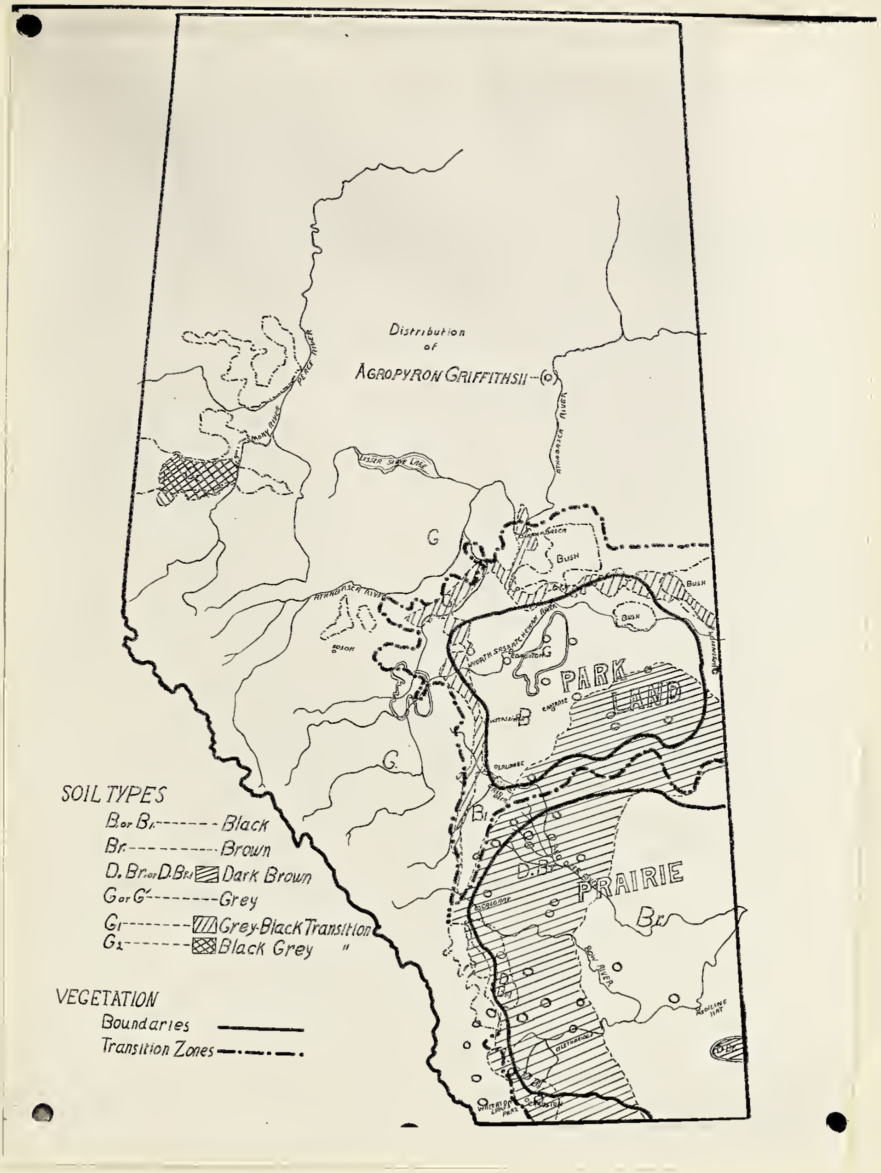


Fig. VII

Distribution of A. Griffithsii in Alberta.

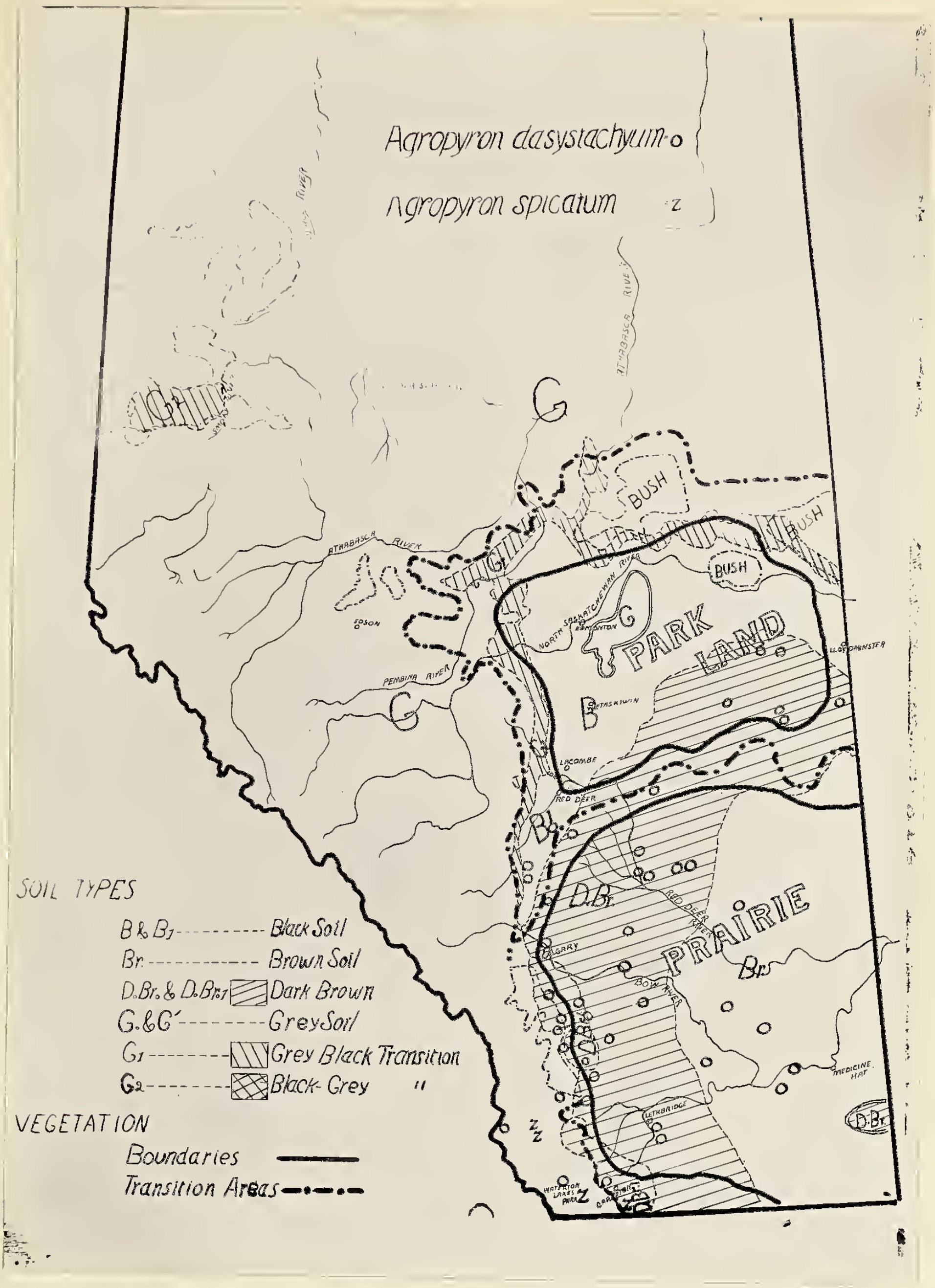


Fig. VIII

Distribution of A. dasystachyum and A. spicatum in Alberta.

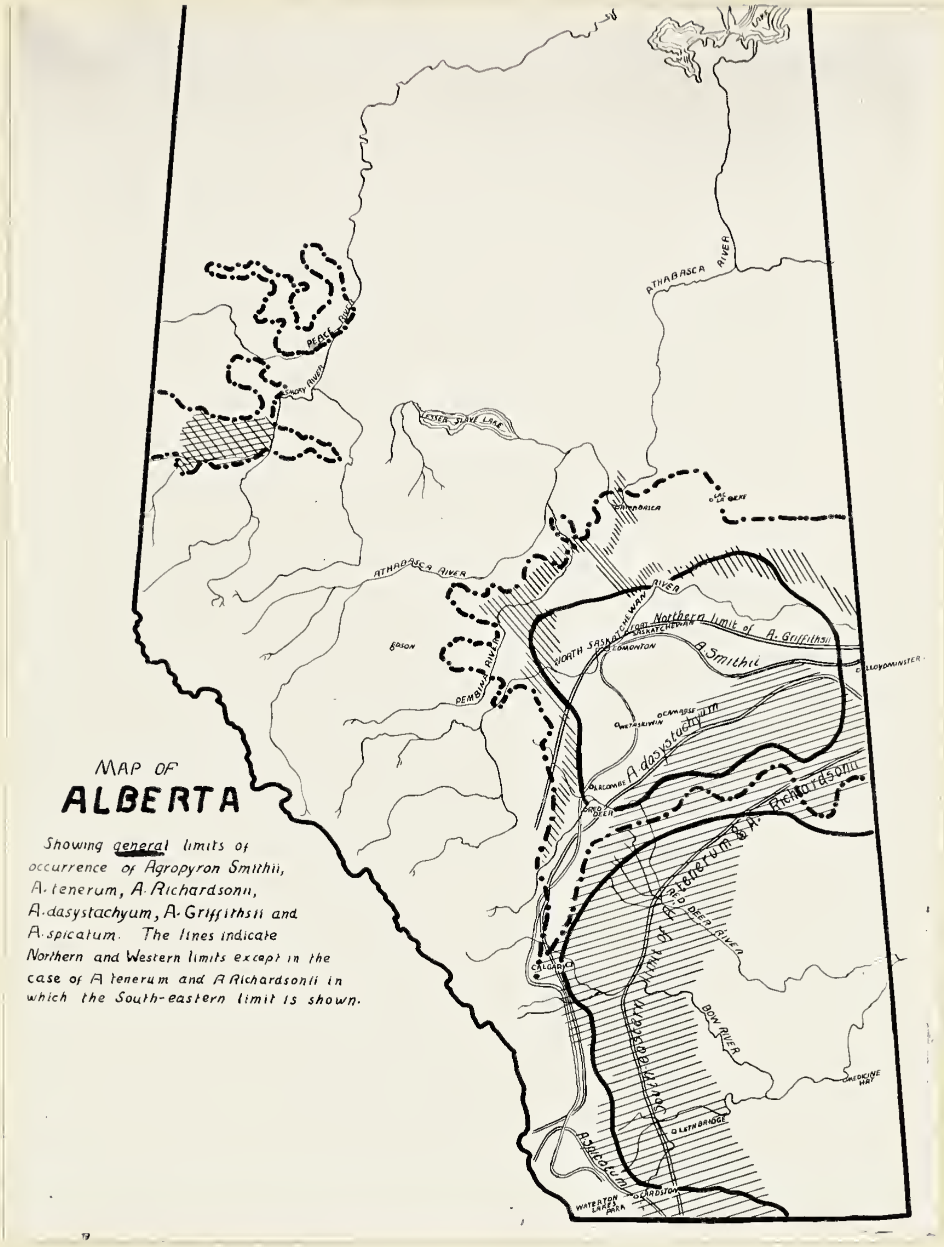

MAP OF
ALBERTA
Showing general limits of occurrence of Agropyron Smithii, A. tenerum, A. Richardsonii, A. dasystachyum, A. Griffithsii and A. spicatum. The lines indicate Northern and Western limits except in the case of A. tenerum and A. Richardsonii in which the South-eastern limit is shown.
PEACE RIVER
SMOKY RIVER
LESSER SLAVE LAKE
ATHABASCA RIVER
ATHABASCA
LAC LA BICHE
EDSON
PEMBINA RIVER
NORTH SASKATCHEWAN RIVER
FORT SASKATCHEWAN
EDMONTON
Northern limit of A. Griffithsii
A. Smithii
LLOYDMINSTER
WETASKIWIN
CAMROSE
A. dasystachyum
LACOMBE
RED DEER
Southeastern limit of A. tenerum & A. Richardsonii
RED DEER RIVER
CALGARY
BOW RIVER
MEDICINE HAT
LETHBRIDGE
A. spicatum
WATERTON LAKES PARK
CARDSTON

Fig. IX

Results

The data obtained during this investigation, as recorded on the survey cards (Fig.IV), are organized and summarized into table form for purposes of analysis, (Table II). The observations contained in this table were utilized to construct maps showing separately the distribution of the species of *Agropyron* and further, to design a map indicating the general northern or southern limits of these species, (Figs. V to IX).

Discussion of Results

It will be necessary before proceeding with a detailed ecological account of the species of *Agropyron* studied to discuss the principal vegetation zones mentioned earlier in the paper, with particular reference to the origin and floristic composition of each.

Ecology and Floristic composition of the principal vegetation zones of Alberta

The origin of the prairies of central United States have been studied quite extensively, and it appears that climatic factors are at least as important as geological factors in the determination of vegetation zones. Schaffner (16) 1926, noted the relation of rainfall and evaporation to the prairie boundaries. He refers to the work of Transeau who has found that the eastern boundary of the long grass prairie is apparently determined by the 80% rainfall-evaporation ratio[1]. and the western

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[1] The rainfall-evaporation ratio is the percentage ratio of the precipitation to the total evaporation at ground level from a free water surface.

boundary by the 60% ratio, while the short grass plains, which correspond to the southern prairie of Alberta are apparently determined by the 20% ratio. There is little doubt that the rainfall-evaporation ratio is of significance in determining the vegetation zones of this province but data on evaporation are so meagre as to have no practical value for comparison studies. Stacey (17) 1927 reports on the work of Kincer, who found that the rate of evaporation decreases from north to south, thus with the precipitation in the southern prairie of Alberta lower than in the corresponding areas of Montana and North Dakota, the rainfall-evaporation ratio would remain practically the same. The increase in precipitation from south to north (Fig.III) and the corresponding decrease in the rate of evaporation results in a rapid increase in the rainfall-evaporation ratio. This change alone could account for the various vegetation zones of the province.

Winds are undoubtedly of extreme significance in determining the rate of evaporation but there are insufficient observations concerning this factor to be of value for the purpose of an ecological study.

The southern prairie or short grass plains.

This area includes the brown soil section of south eastern Alberta, together with the dark brown soils to the west (Fig.V).

The southern prairie is characterized by the *Bouteloua - Stipa - Koeleria* association which is similar to the prairie of North Dakota and Montana, with the exception that *Koeleria gracilis* which is regularly a primary species of the short

grass plains of United States becomes a dominant grass in the southern and northern prairies of Alberta (15). The dominant and primary species of this area are (2):

Bouteloua gracilis (blue gramma grass)
Stipa comata (spear grass)
Koeleria gracilis (June grass)
Agropyron Smithii (blue-joint or western wheat grass)
A. dasystachyum (hairy wheat grass)
Poa confusa
Poa laevigata
Poa crocata
[1] Carex filifolia

Northern prairie or transition prairie

The transition prairie **is** a tension zone between the short grass plains and the wooded areas and for the most part is very indefinite as to boundaries but as a rule includes the dark brown soils.

The area between the southern prairie and the foothills south of Calgary is characterized by a mixture of true prairie grasses and those common to the wooded areas of southern Alberta. The most common dominant and primary species observed were:

Stipa comata
Agropyron Smithii
A. tenerum
A. Richardsonii
Koeleria gracilis
Bouteloua gracilis
Avena Hookeri

1. The Carices for the sake of convenience are included with the grasses.

The portion of the transition zone more commonly known as the northern prairie includes the dark brown soils within the parkland area and the black soils south of Lacombe. In this area are found both true prairie grasses and those characteristic of the northern poplar association; the distribution varying with differences in slope, soil and moisture. The chief grasses observed in this section are:

Stipa comata
Koeleria gracilis
Agropyron Smithii
Stipa viridula
Festuca scabrella
Agropyron tenerum
A. Richardsonii
Stipa columbiana
Agropyron Griffithsii
Calamagrostis canadensis.

The parkland

The parkland includes the black soil area north of Lacombe and the northern section of the dark brown soils. This division comprises chiefly a poplar association with areas of prairie interspersed. Previous reference has been made to this area in the discussion on the northern prairie. It may be noted here that the grasses of the parkland are practically the same as those of the northern prairie with the exception that few of the grasses of the short grass plains are present, (Table III).

Table III

	Dry areas: Higher levels, South slopes.	Intermediate: North slopes and bottoms of depressions	Wet areas: close to lakes, sloughs, springs, etc.
Short grass plains	Bouteloua gracilis Stipa comata Koeleria gracilis Agropyron Smithii A. dasystachyum Poa spp. Festuca spp. Carex filifolia	Agropyron tenerum A. Richardsonii K. gracilis S. comata B. gracilis A. Smithii	Poa triflora P. pratensis A. Smithii A. Griffithsii Puccinellia Nuttalliana Panicularia Grandis Beckmania erucaeformis Phalaris arundinacea Calamagrostis canadensis Juncus spp. Carex spp.
Northern prairie	Stipa comata K. gracilis A. Smithii A. Griffithsii A. tenerum A. Richardsonii Poa interior	Poa triflora P. pratensis A. tenerum A. Richardsonii Festuca scabrella Stipa viridula S. columbiana A. Griffithsii Agrostis hyemalis B. ciliatus	Calamagrostis canadensis Bromus ciliatus Poa triflora
Poplar Ass'ns.	A. tenerum A. Richardsonii B. ciliatus Elymus innovatus Avena striata ((Schizachne purpurascens (Torr.) Swallen))	C. canadensis A. tenerum A. Richardsonii B. ciliatus P. triflora A. hyemalis A. striata	
Pine Ass'ns.	E. innovatus F. scabrella Oryzopsis asperifolia (Ledum) (Vaccinium)		Carex spp. Sphenopholis Poa spp.

N.B. Arrows represent a similarity of associations between groups indicated.

The wooded areas

The wooded areas of Alberta include the poplar associations of the parkland, the northern mixed forest and the Cordilleran forest. The poplar association of the parkland has already been discussed, while this investigation did not extend into the Cordilleran forest.

The northern mixed forest includes the poplar, spruce and pine associations north and west of the parkland and for the most part includes the grey soils of the province. While sections of pine and spruce were occasionally encountered, studies were chiefly confined to the poplar association.

The grasses of the poplar and spruce associations are fundamentally the same, but undergrowth in the poplar areas is usually much more abundant than in the spruce. The chief grasses of this area are *Calamagrostis canadensis* and *Agropyron* spp., but their frequency and distribution var~~ies~~y with slope, soil and moisture, (Table III).

The pine association is chiefly confined to sandy areas which occur throughout the northern mixed forest. Few observations were made on the grasses of this association but some of the most commonly observed were as follows; (Table III):

Elymus innovatus
Festuca spp.
Oryzopsis spp.
Agropyron tenerum
Agropyron Richardsonii
Calamagrostis spp.

Ecology of the Alberta Species of Agropyron

In the following discussion six species of Agropyron will be treated in reference to their individual ecological relationships. As previously mentioned A. Richardsonii and A. tenerum have an almost identical range of distribution, so these concomitant species will be included together. Following this discussion the inter-relationships of these species will be treated briefly with a view to showing the factors which appear to be most significant in causing the variations in distribution.

Agropyron Smithii Ryd.

A. Smithii is a native of the prairies of western and central North America, particularly of the short grass plains and the transition zone between the short grass plains and the long grass prairie. It is a primary constituent of the southern and northern prairies of Alberta, with a less frequent occurrence in exposed areas of the foothills and the Peace River district, (Tables II and III, Figs. V and IX).

This species is practically confined in Alberta to the brown and dark-brown soil areas although it is frequently found on south slopes and exposed ridges in the black soil section. In the foothills country south of Calgary, A. Smithii occurs on weathered soils, while in the Peace River district it is found on the dark or grey soils in exposed locations.

The general northern limit may be placed along a line from Olds to Edmonton and east to Lloydminster, but this species

occurs as far north as the Peace River district and has been reported from the Battle river country (6).

Although A. Smithii regularly occurs on the brown and dark brown soils, Clarke (2) 1930 and Schaffner (16) 1926 point to the occurrence of this species in pure stands on the clay soil areas, particularly on small alluvial deposits and on the summits of ridges. Schaffner noted that almost pure stands of A. Smithii often occur between the Bouteloua and Bulbilis associations on the slopes of hills and depressions; also, on the long grass prairie this species marks the position of old wagon tracks and buffalo trails.

The relative importance of A. Smithii to the associated species is a matter of some controversy, (2, 15, 16). All authorities are agreed, however, that it comprises a primary species on the short grass plains and transition prairie. Observations made in the southern part of Alberta indicate that A. Smithii has practically the same frequency as any of the dominant species. Clarke (2), however, regards it as one of the primary species. The frequency with which it has been observed is no doubt due to its prevalence along roadsides and to its occasional occurrence in pure stands.

Thus, Clarke's work indicates that in the southern prairie A. Smithii is not ordinarily a dominant grass, but, along roadsides, near irrigation ditches, and on small alluvial deposits it often appears in practically pure stands, while it is one of the first species to invade abandoned farms.

In the northern prairie associations A. Smithii retains practically the same relative importance as in the south. The

northern limit of distribution of this species, for the most part follows the boundary of the dark brown soils but on exposed sections of the black soil area, particularly on the higher levels it remains a primary species. As this area is one of the most important farming districts of the province it was difficult to find sections representative of the original prairie.

The associations in which A. Smithii is found have already been discussed at some length. In the short grass plains of the south of the province this species occurs in the Bouteloua - Stipa - Koeleria association as a primary species. The characteristic vegetation, including the carices and the most important of the broad-leaved plants are as follows (2):

Bouteloua gracilis
Stipa comata
Koeleria gracilis
Agropyron Smithii
A. dasystachyum
Poa confusa
Poa laevigata
Poa crocata
Carex filifolia

Atriplex Nuttallii
A. argentea
Artemesia frigida
A. cana
Eurotia lanata
Aragallus galisides
A. gracilis

Achillea lanulosa

Cactus spp.

In the northern prairie *A. Smithii* occurs in the *Koeleria* - *Stipa* and the *Koleria* - *Agropyron* associations. Although *S. comata* and *B. gracilis* are less frequent than in the short grass plains, *Koeleria* remains a dominant species throughout while *A. Smithii* retains practically the same relative importance as in the southern prairie. Along roadsides, particularly toward its northern limit of distribution, *A. Smithii* is usually associated with *A. tenerum*, *A. Richardsonii*, *Poa triflora* and *P. pratensis*.

A. Smithii has practically the same relative importance in the prairie areas of the Peace River district as it has in the northern prairie. In this district it is chiefly confined to the clay soils on prominences and south slopes, (17).

A. Smithii-molle, although differing from *A. Smithii* in texture and pubescence of the lemma was observed to have practically the same ecological relationships.

Agropyron Richardsonii (Trin.) Schrad.

Agropyron tenerum Vasey

A. Richardsonii and *A. tenerum* are the most abundant species of *Agropyron* in Alberta, and moreover were observed to have a greater range of distribution than any other grass species in the province.

Observations have shown that *A. Richardsonii* occurs somewhat more frequently on the short grass plains than *A. tenerum*. Although Clarke (2) makes no record of similar observations, evidence obtained by the writer indicates that the forms of

A. Richardsonii common to southern Alberta are more drought resistant than the strains of *A. tenerum* present in this section. Further observations and experiments, however, are necessary to determine this point.

As *A. tenerum* has been brought under cultivation and is therefore widely disseminated throughout the province, it was often found difficult in the irrigated districts to determine whether the presence of this species was natural or otherwise, and for this reason it is reported in many cases in the south, where in all probability it has simply escaped from cultivation.

A. Richardsonii and *A. tenerum* occur most abundantly in the northern prairie, parkland and poplar associations but even in the driest sections of the short grass plains they are rarely absent. The northern limit of distribution has not been determined, but there is little doubt that these species are present to the northern limit of the poplar association. In the pine and spruce associations of the north they are relatively unimportant.

These species are characteristic of the grey, black and dark brown soils of the province and their occurrence on the brown soils is apparently conditioned only by the moisture supply.

A study of the distribution of *A. tenerum* and *A. Richardsonii* in relation to the precipitation shows that ordinarily these species occur where the annual precipitation is above 15 inches, or above 19 inches in the south western part of the province.

These species are secondary in the short grass plains, primary species, in most cases, in the transition prairie and co-dominants in the *Agropyron* - *Calamagrostis* association of

the poplar woods. The same relative importance is reported by Moss (6) for the Peace River district, although the associated species vary somewhat.

Although sufficient observations have not yet been made to establish definitely the relative frequencies of the grasses of the various associations, Moss (6) has made a number of observations in the poplar associations of the province, (Table IV).

Table IV

Frequencies of some of the principal herbs in the poplar association (6)

	Constancy: Percentage of stands in which species were found			frequency indices of species		
	Balsam stands	Balsam aspen stands	Aspen stands	Balsam poplar consociation	Balsam aspen vegetation	Aspen consociation
A. tenerum	90	100	80	7.8	5.9	5.9
A. Richardsonii	84	75	77	5.2	5.7	5.5
B. ciliatus	56	58	74	3.5	3.8	4.3
C. canadensis	90	91	87	12.8	9.2	8.7
Poa triflora	42	17	14	0.6	0.4	0.3
Poa pratensis	14	0	10	0.1	---	0.1
Lathyrus ochroleucus	84	91	94	1.0	6.2	5.9

Table IV represents but a small number of the species observed but includes some of the most frequent species of grasses together with the most abundant form of peavine. *A. tenerum* and *A. Richardsonii* combined were found to be rather more abundant than

Calamagrostis canadensis. These are the dominant grasses of the poplar association.

The relative frequencies of the species of Agropyron to the other herbs in the northern prairie and pine and spruce associations have received little attention. Undergrowth in the pine and spruce associations is very sparse, however, and species of Agropyron are of comparatively rare occurrence. In the northern prairie, on the other hand, A. tenerum and A. Richardsonii are of considerable importance, as is also the case on the transition prairie south of the black soil area. While the order of importance varies locally with variations in soil, moisture, slope and shading the chief grasses observed on the transition prairie south of Lacombe are as follows:

Agropyron Smithii
A. Richardsonii
A. tenerum
Koeleria gracilis
Avena Hookeri
Agropyron Griffithsii
Elymus Macounii

In the northern prairie associations north and east of Lacombe more observations have been made in relation to the distribution and frequency of the principal grasses. These may be divided into two classes: (a) typical of the southern prairie, and (b) typical of the northern prairie, (Table III). The following lists are arranged to show as nearly as possible the order of importance of the primary species:

(a) Typical of the southern prairie	(b) Typical of the northern prairie
Koeleria gracilis	K. gracilis
Stipa comata	A. tenerum
S. viridula	A. Richardsonii
Bouteloua gracilis	Poa triflora
Agropyron Smithii	Festuca scabrella
A. Griffithsii	Stipa columbiana
A. tenerum	
A. Richardsonii	Poa pratensis

Agropyron Griffithsii Scribn. & Smith

Agropyron Griffithsii has been found to have a range of distribution similar to that of A. Smithii, with the exception that the former is practically confined to the dark brown soils of the province, (Figs. VII and IX , Tables II and III). It was observed most frequently between Wainwright, Viking and Tofield, becoming less abundant toward Brooks, Drumheller and Standard. Between Edmonton and Calgary A. Griffithsii is quite common and occurs south-west to Cardston and Waterton Lakes.

Besides regularly occurring on the dark brown prairie soil, this species was frequently observed on alkali flats associated with Hordeum jubatum and even with Distichlis stricta.

A. Griffithsii regularly occurs in the Koeleria - Stipa, and Agropyron - Koeleria associations. When it occurs in the short grass plains it is not in the driest locations, but on north slopes and the bottoms of depressions.

It thus appears that A. Griffithsii has a rather narrow range of tolerance in relation to water requirements and for the most part it is characteristic of but one type of soil, namely the dark brown soil. It is found, however, to occur also, under moderately alkaline conditions.

A. Griffithsii has been found in the Peace River district and for a considerable distance north[1]. Some forms were observed which, while similar to A. Griffithsii were not typical of the species and further studies are apparently necessary to determine the relationships of these forms.

Agropyron dasystachyum (Hook.)Scribn.

A dasystachyum is found in the southern and northern prairie of Alberta and has almost an identical distribution with A. Smithii, (Figs. VII and IX). It was found difficult at all times to be certain of the identity of this species, for in the dry areas few or no culms are produced, and often it was difficult to differentiate it from A. Smithii-molle. For this reason, closer observations would no doubt prove this species to have a greater frequency than the present study indicates. Clarke (2) lists A. dasystachyum as next in importance to A. Smithii on the short grass plains while Moss (6) does not differentiate between these two species, (Fig.I).

Although information on the relative frequency of A. dasystachyum is of uncertain value, other ecological relationships are evident and apparently similar to those of A. Smithii.

[1] Verbal information.

In the southern prairie A. dasystachyum is a characteristic of the brown soils and a constant feature of the Drumheller clay soil.

This species is apparently less tolerant of excessive moisture than A. Smithii as it was rarely found near irrigation ditches where the latter often occurs in pure stands.

On the northern prairie A. dasystachyum is found in both the Koeleria - Agropyron and Koeleria - Bouteloua - Stipa associations.

It has been shown in the foregoing that A. dasystachyum has practically the same ecological relationships as A. Smithii except that its lower drought resistance effects the production of floral parts and identification is often difficult. Further this species is often confused with A. Smithii-molle so it has been impossible to estimate its relative importance.

Agropyron spicatum (Pursh.) Scribn. & Smith.

It has already been shown that A. spicatum is of rare occurrence in Alberta, being confined to the extreme south-western portion chiefly in the foothills. This species has been authentically reported from only three locations: viz. Waterton Lakes, Cardston and Lundbreck. Sampson (14) 1924, however, indicates the northern limit as extending well into central Alberta, including most of the southern prairie. This is no doubt due to confusion of this species with A. Griffithsii which it resembles very closely.

A. spicatum is one of the important bunch grasses of the

western short grass plains of United States and is said to occur frequently in the dry ranges of southern British Columbia (14). In Alberta this species is found on sandy soils in the pine scrub close to the water's edge in Waterton Lakes Park and on the loose soil of the open prairie in the foothills north of Lundbreck.

This species is very drought resistant as indicated by its occurrence on sandy well drained soils. It is, however, a bunch grass with long fibrous roots which penetrate to considerable depths on the loose soil on which it regularly occurs.

The associations in which A. spicatum occurs have not been studied closely. The associated species observed were as follows:

Agropyron Smithii
Stipa comata
Avena Hookeri
Elymus canadensis
Agropyron tenerum
A. Richardsonii
A. Griffithsii

Conclusion

The species of *Agropyron* studied have been shown to differ markedly in certain respects. Ecologically, they may be divided into two groups: (a) with an optimum annual rainfall requirement of over 15 inches, in which are included *A. Richardsonii*, *A. tenerum* and possibly *A. spicatum*: (b) with a rainfall requirement of less than 15 inches in which are included, *A. Smithii*, *A. Griffithsii*, *A. dasystachyum* and *A. Smithii-molle*.

The species of the first group are bunch grasses with fibrous roots, shallow in the case of *A. Richardsonii* and *A. tenerum* and long in *A. spicatum*. This type of root system is apparently not capable of withstanding long periods of desiccation, while the rootstocks of the species of the second group are able to penetrate hard soils and to remain dormant during periods of drought.

The method of propagation differs also, in the two groups. *A. Richardsonii* and *A. tenerum* reproduce entirely by seed which they produce abundantly, (11). *A. spicatum* probably produces seed less abundantly but further observations are necessary to establish this point.

A. Smithii, *A. Griffithsii*, *A. dasystachyum* and *A. Smithii-molle* on the other hand are dependent chiefly on rootstocks for propagation as they are poor "seed setters". It is probably significant that *A. Smithii* which possesses the most vigorous rootstocks has the most consistent range of distribution of these species throughout the prairie.

Summary

1. The distribution of the species of Agropyron in Alberta was studied with respect to their ecological relationships. Incidental to this study observations were made regarding other native grasses.

2. The vegetation divisions of the province were found to be characterized by definite soil types and plant associations. The southern prairie (short grass plains) of the brown soils belongs to the Stipa - Bouteloua - Koeleria association. The northern (transition) prairie, chiefly of the dark brown soils, is characterized by species of the short grass plains and poplar associations. The parkland covering the black soil area and the northern section of the dark brown soils has a similar range in floristic composition. The wooded area of the grey and black soils belong chiefly to the poplar association and the dominant grasses are usually Calamagrostis and Agropyron.

3. A. Smithii occurs on the prairie areas of the brown and dark brown soils in the Stipa - Bouteloua - Koeleria associations.

4. A. tenerum and A. Richardsonii with the widest range of distribution of any of the native grasses, are secondary species in the southern prairie, primary in the

in the transition prairie and dominant grasses in the poplar association .

5. A. Griffithsii, which is practically confined to the dark brown soils is a prairie grass and occurs in the same associations as A. Smithii.

6. A. dasystachyum, although slightly less drought resistant, was otherwise found to have the same ecological relationships as A. Smithii.

7. A. spicatum appears to be confined to the foothills of south-western Alberta and was observed in the mixed prairie on sandy locations.

8. The species of Agropyron studied were found to be divided naturally into two groups, (a) bunch grasses, propagated entirely by seed, with an optimum annual rainfall requirement of over 15 inches, in which are included, A. tenerum, A. Richardsonii and A. spicatum, (b) with creeping rootstocks, dependent chiefly on vegetative propagation and with an annual rainfall requirement of less than 15 inches, in which are included A. Smithii, A. Griffithsii, A. dasystachyum and A. Smithii-molle.

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